

June 14, 1966

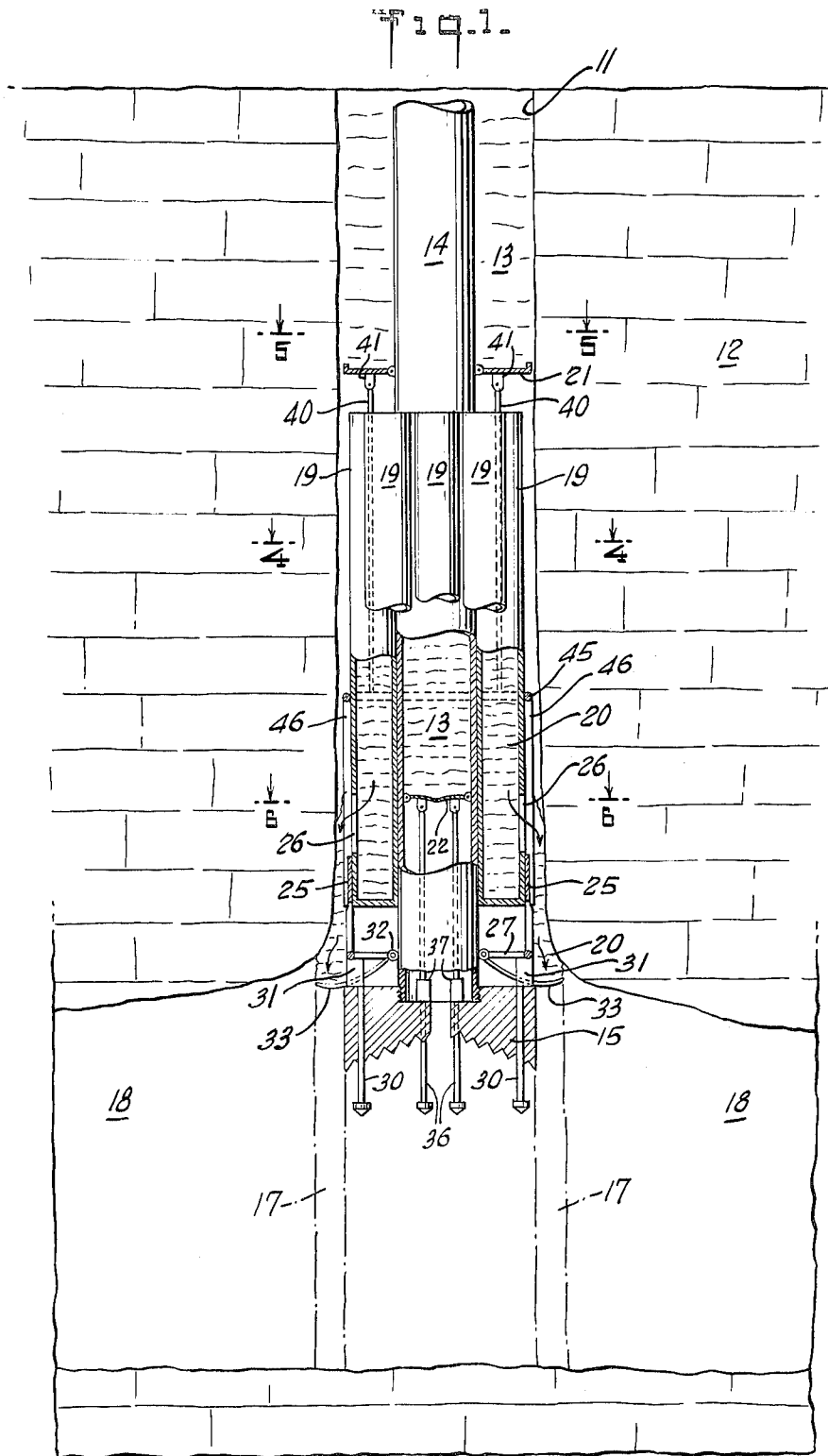
P. F. KERR

3,255,833

DRILL BIT AUXILIARY

Filed Oct. 10, 1963

3 Sheets-Sheet 1



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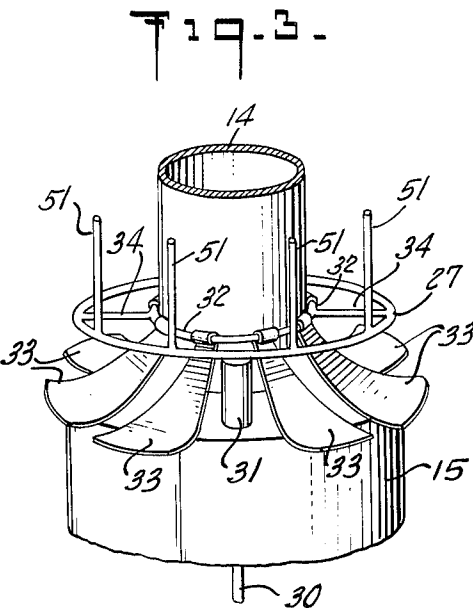
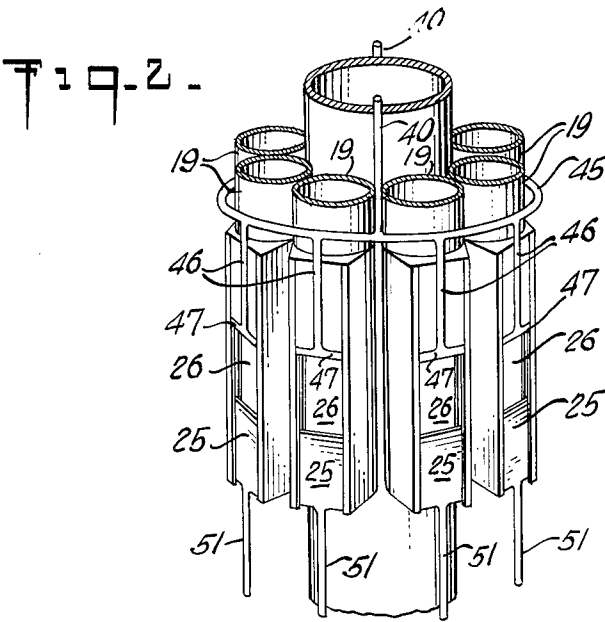
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DRILL BIT AUXILIARY

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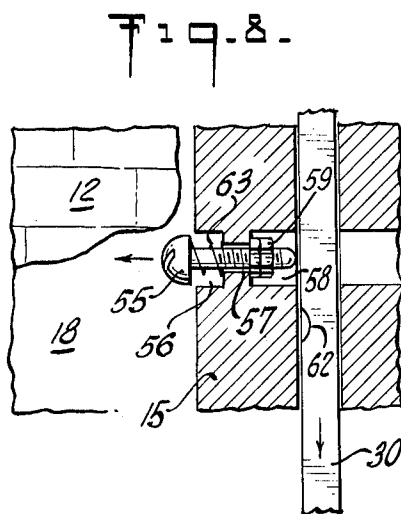
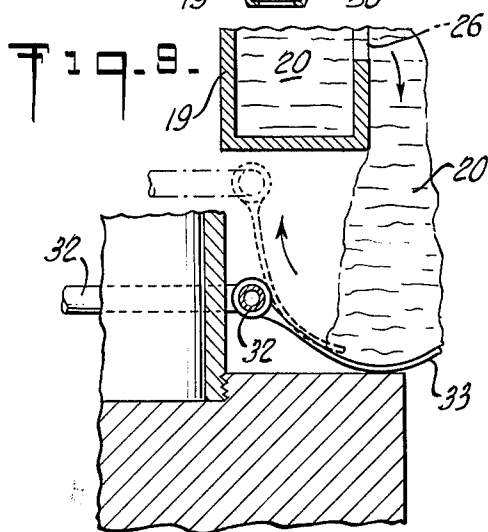
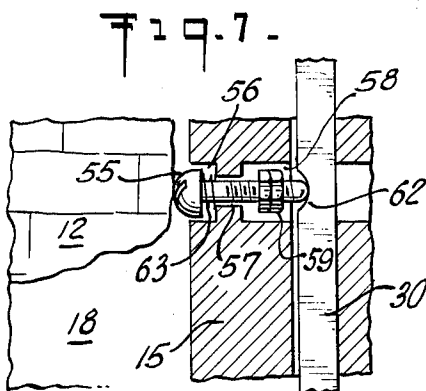
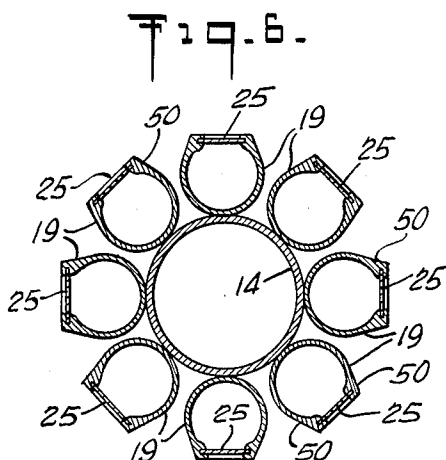
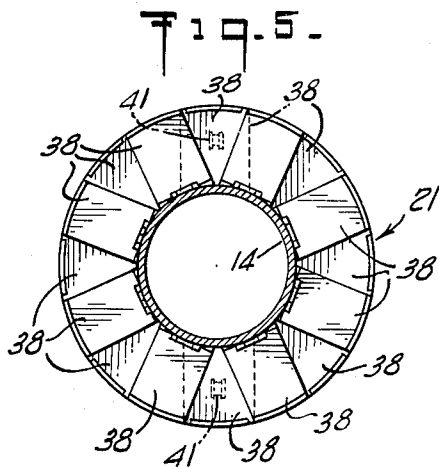
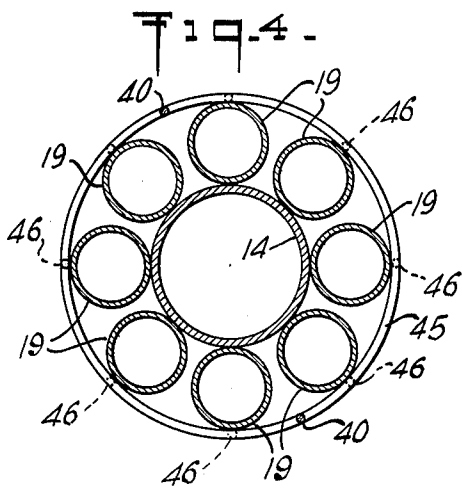
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DRILL BIT AUXILIARY

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## DRILL BIT AUXILIARY

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9 Claims. (Cl. 175-24)

This invention concerns auxiliary apparatus for drilling in the earth. More specifically, it relates to auxiliary structure applicable to a rotary drill, particularly of the type normally employed in deep well drilling operations, usually for petroleum products.

A problem encountered quite often in drilling deep wells, particularly those for oil or gas, is that of so-called blind holes or the loss of return circulation of the drilling fluid. This invention is applicable to the situation where loss of circulation is due to a cavern encountered as the hole is drilled. Thus, it is an object of this invention to provide apparatus that may be employed with a rotary drilling bit so as to apply a wall-building paste around the drill bit whenever a cavern, or open space is encountered during the drilling.

Another object of the invention is to provide auxiliary apparatus applicable to rotary drill structure having means associated with the bit for sensing a loss of formation under the bit. Such sensing means is then applied to operate paste-containing tubes so as to extrude the paste around the drill bit, in order to form a wall of paste which will block the opening encountered.

Briefly, the invention is applicable to rotary well-drilling apparatus and relates to a drill bit auxiliary. The auxiliary comprises means containing a paste for forming a wall at a cavern, encountered during drilling. It also comprises means associated with said bit for releasing said paste when said cavern is encountered.

The foregoing and other objects and benefits of this invention will be more fully appreciated in connection with the detailed description which follows, and which is illustrated in the drawings wherein:

FIGURE 1 is a schematic cross-sectional view of the entire structure according to an embodiment of the invention, all shown located downhole adjacent to a subsurface cavern;

FIGURE 2 is an enlarged fragmentary perspective view showing the sliding doors located near the lower ends of the paste tubes, which surround the drill stem;

FIGURE 3 is another enlarged fragmentary perspective, showing the upper portion of the drill bit and illustrating the paste distributing members;

FIGURE 4 is an enlarged cross-section view taken along the lines 4-4 of FIGURE 1;

FIGURE 5 is another enlarged cross-section taken along the lines 5-5 of FIGURE 1;

FIGURE 6 is another enlarged cross-section taken along the lines 6-6 of FIGURE 1;

FIGURE 7 is an enlarged fragmentary vertical cross-section illustrating the release structure for allowing the sliding doors to open as a cavern is encountered;

FIGURE 8 is a similar enlarged fragmentary vertical cross-section as that of FIGURE 7, illustrating the position of the elements after a cavern has been encountered; and

FIGURE 9 is an enlarged fragmentary vertical cross-section illustrating the action of the paste distributing member as a cavern is encountered.

FIGURE 1 illustrates an embodiment of the invention and shows how it would operate during the drilling operation, when an open space or cavern is encountered downhole. Thus, as a hole 11 is drilled in a subsurface formation 12 which is relatively solid, e.g., that illustrated with the reference numeral 12 applied thereto; the oper-

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ation will be such as to provide for drilling fluid 13 (usually called mud) to be circulated in a standard manner, i.e., down within the hollow center of a drill stem or pipe 14. The mud 13 flows also through a drill bit 15 and then is circulated upward around the bit and within the annulus formed within the hole 11 surrounding the drill stem 14, so as to clear away the cuttings made by the drill bit and carry them to the surface. However, if lost circulation conditions are encountered, the auxiliary apparatus according to this invention becomes effective as described hereafter.

Thus, when a cavern is encountered, such as a cavern 18 illustrated, it will not cause a loss of circulation of the drilling mud 13 which would ordinarily take place by reason of the mud 13 flowing out into the cavern 18 and therefore failing to return up through the hole 11 within the annulus surrounding the drill stem 14. The action of the auxiliary apparatus for accomplishing this will be better understood as a more detailed description thereof is given below.

Referring to FIGURE 1 and the other figures of the drawings, it will be observed that there are a plurality of paste tubes 19 that are arranged peripherally surrounding the drill stem 14 just above but adjacent to the drill bit 15. These paste tubes 19 will be long enough to contain an adequate amount of a heavy, viscous, slow-flowing paste 20 which will be used to build up a cylindrical wall, e.g., a wall 17 which extends vertically through any cavern, such as the cavern 18 illustrated. The wall 17 is indicated by broken lines in FIGURE 1. The paste, of course, will be a material having adequate strength and adhesive qualities to build the wall in such manner that it can withstand the pressures to which it must be subjected after drilling is resumed.

In order not to dilute the wall building paste 20 as it is extruded from the paste tubes 19, there are provided two separate valves 21 and 22 which act respectively to close the annulus and to cut off the drilling mud circulation within the drill stem 14 during the time that the paste is being extruded from the paste tubes 19. The details of the structure for these valves may vary but will be described in greater specificity below according to the illustrated embodiment of the invention.

It will be observed that the valves 21 and 22 are operated in conjunction with the operation of a plurality of sliding doors 25 that act to close a corresponding plurality of ports or windows 26, one located near the bottom of each of the paste tubes 19. These sliding doors 25 are actuated from a supporting ring 27 that surrounds the drill stem just above the bit 15. The vertical position of ring 27 is determined by a plurality of drop rods 30 which have enlarged stop shoulder portions 31 located above the top surface of the bit 15. In addition there is an inner ring 32 that is attached to ring 27 by radial rods 34. Also ring 32 has attached thereto a plurality of paste catching members 33. These paste catching members are hinged at the ring 32 so that they may be retracted (as is illustrated in FIGURE 9 by the dashed line showing) when the drop rods 30 are moved vertically upward to the retracted positions thereof. The latter takes place when the bit is in contact with the subsurface formation.

The operation of the inner valve 22 is controlled by a different set of drop rods 36 that are located radially inward relative to the drop rods 30, but similarly extend vertically through the body of the bit 15. Drop rods 36 have enlarged stop shoulders 37 which prevent the drop rods from moving vertically downward beyond a predetermined distance and also support the valve structure of valve 22 when it is in its closed position.

The upper valve 21 is for cutting off drilling mud circulation in the annulus. It is located above the top

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of the paste tubes 19 and surrounding the exterior of the drill stem 14. This valve 21 is constructed of a plurality of overlapping hinged flaps or petals 38. Actuation of these petal elements of valve 21 is carried out by a plurality of vertically extending rods 40 that are attached to certain of the petals which make up the valve 21. These petals are attached in each case by a clevis 41 and hinge pin as shown. The clevis is attached to one of the petals of the fan type structure which lies underneath adjacent petals thereof. This structure is shown in greater detail in FIGURE 5 where it will be observed that there are alternate petals 38 with the two clevises 41 being attached to oppositely located ones of the petals 38. By having this structure, when the rods 40 are vertically raised they will move the petals 38 (having the clevises 41 attached thereto) so as to cause all of the petals to pivot about their hinges which are fastened to the outside of the drill stem 14, as illustrated. Thus, when rods 40 are moved vertically upward they cause all of the petals 38 to fold against the drill stem 14 and thus leave the annulus surrounding the drill stem open.

Movement of the rods 40 is carried out by the supporting structure thereof which includes a ring 45 that surrounds the paste tubes 19 and to which ring the rods 40 are attached. Also attached to the ring 45, but extending vertically downward therefrom there are a plurality of rods 46. Each of the rods 46 have attached to the lower end thereof a cross member 47 (FIGURE 2) that may slide vertically in grooves 50 (FIGURE 6). The grooves 50 are located on the inner edges of that portion of the paste tubes 19 which contain the windows 26. Cross members 47 will encounter a stop surface (not shown) in the grooves 50 at the upper edge of the windows 26 to limit the downward movement of the whole supporting structure for the rods 40 so that the fan valve 21 will be stopped in its extended or closed position. However, they are free to move or slide vertically upward from this position so as to carry the ring 45 upward and consequently move the rods 40 up in order to open the valve 21.

It will be observed that movement of the cross members 47 upward in the grooves 50 is caused by the vertically sliding doors 25 when they have contacted the cross members after having closed the windows 26. Furthermore, actuation of the doors 25 takes place by reason of movement of attached rods 51 which extend downward from the bottom of the doors 25 and are connected to the ring 27. Ring 27 rests on and is moved by the drop rods 30 and stop shoulders 31.

In order to provide for holding the windows 26 closed and the valves 21 and 22 open during normal drilling operations, there is a latching structure in connection with the drop rods 30, such as that illustrated in FIGURES 7 and 8. This latching structure includes a round headed bolt 55 that is carried in a recess 56 in the bit 15. There is also a passageway 57 that connects the recess 56 with an inner enlarged hole or space 58 that is large enough to accommodate a locking pair of nuts 59 that are placed on the bolt 55 to act as a stop for the extended position of the bolt. The inner end of bolt 55 extends into a notch 62 located in the corresponding drop rod 30 when the bolt 55 is held in its retracted position by the presence of a solid formation wall, e.g., the formation 12 as illustrated in FIGURES 7 and 8. There is a coil spring 63 which surrounds the body of bolt 55 and rests against the flat side of the head of the bolt at one end and against the flat surface of the recess at the other end of the spring.

As illustrated in FIGURES 7 and 8 the latching arrangement is such that the drop rods 30 will be held upward in their retracted position by the latching action of bolt 55 cooperating with the notch 62 so long as the bolt is in its retracted, or radially inward, position. The latch will remain engaged so long as the walls of the

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hole being drilled are sufficiently solid. However, whenever a cavern or opening in the subsurface formations is encountered then the bolt 55 will move radially outward under pressure of the spring 63, to the position illustrated in FIGURE 8. This then releases the drop rods 30 so that the doors 25 will slide down and first close the fan valve 21 and then open the windows 26 to allow the paste 20 to be extruded from the tubes 19. The drop rods 36 will already have been released by absence of any formation below the bit, so that the downward circulating mud stream will have already been cut off by the consequent closing of the valve 22.

#### OPERATION

The operation of the apparatus according to this invention will be described in relation to the conditions existing during a drilling procedure as the drill reaches a cavern or opening in the subsurface formation. Thus, it is to be noted that as soon as such a cavern (e.g., cavern 18 illustrated in FIGURE 1) is reached the drop rods 30 will move vertically downward relative to the bit 15 as soon as the latching mechanism has released the drop rods. However, before this action of downward movement of drop rods 30 takes place, the drop rods 36 will have been released by the lack of formation under the bit 15 and the valve 22 will have been closed to cut off the flow of drilling mud 13.

When the drop rods 30 are released by the latching mechanism, as the bit 15 enters the cavern, their downward movement causes opening of the doors 25 to allow outward flow or extrusion of the paste 20 through the ports or windows 26, to take place. Also, opening of the doors 25 first allows downward movement of the cross members 47 and consequently movement of the rods 49 which control the upper fan valve 21. This fan valve 21 then blocks circulation of drilling mud through the annulus within hole 11 surrounding the drill stem 14. Then, although the pressure existing down hole acts upon the paste 20 within the tubes 19, gravity or total pressure differentials will cause the paste to be exuded outward through the windows or ports 26 and down around the lower end of the paste tubes 19 until it contacts the outer edges of the paste catching members 33 which are now extended by reason of the downward movement of the ring 27 and connected inner ring 32 to which the mud catching members are attached. It will be appreciated that centrifugal force involved in the rotation of the whole unit (with drill stem 14 and bit 15) will act to assist the flow of paste 20 out of the tubes 19 so as to produce a slow extrusion rather than a mere exusion. The paste 20 will then build up to form the cylindrical wall 17 which will extend downward as long as there is sufficient paste, and will thus provide a closure or seal for the cavern 18 so that the drill bit may continue without loss of circulation in the formation beneath.

It will be appreciated by anyone skilled in the art that in order for the foregoing build up of the paste 20 to form a cylindrical wall 17, as indicated, the proper consistency of the paste will be necessary. Such consistency will include sufficient body and/or adhesive quality (relative to the bore hole wall) to ensure that paste will be added to the lower end of the wall as it is formed.

Thus, the hole 11 may continue and as the hard formation is once more contacted below the cavern 18, the stop rods 30 and 36 will be retracted vertically upward and will return the valves 21 and 22 respectively to their open positions while also retracting the paste catching members 33 and closing the windows 26 at the same time. In this manner all of the elements will be restored to the normal position for drilling, and the cavern will have been effectively sealed off.

While a particular embodiment according to this invention has been described above in considerable detail in accordance with the applicable statutes, this is not

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to be taken as in any way limiting the invention but merely as being descriptive thereof.

I claim:

1. In rotary well drilling apparatus including a bit and a stem therefor, a drill bit auxiliary adapted for applying paste to form a cavity sealing wall comprising a tube means surrounding the stem of said bit for containing said paste and having a closeable opening for extruding said paste, and means associated with said bit for holding said opening closed so long as formation is being encountered by the bit.

2. In rotary well drilling apparatus including a bit and a stem therefor, a drill bit auxiliary adapted for applying paste to form a cavity sealing wall comprising a plurality of paste tubes surrounding the stem of said bit for containing said wall building paste therein, each of said tubes having an extrusion port near the base thereof, a plurality of vertically slideable doors for closing said ports, and means associated with said bit for holding said doors closed in the presence of a formation under the bit while drilling.

3. In rotary well drilling apparatus including a bit and a stem attached thereto in supporting relation thereof, said stem having an axial passage there-through for allowing drilling fluid to be circulated therein, a drill bit auxiliary adapted for applying paste to form a cavity sealing wall comprising a plurality of paste tubes surrounding the stem of said bit for containing said wall building paste therein, each of said tubes having an extrusion port near the base thereof, a plurality of vertically slideable doors for closing said ports, formation sensing means associated with said bit, first and second valve means attached to said stem for cutting off the circulation of drilling fluid in said stem and in the annulus around said stem, and means actuated by said sensing means for opening said ports and closing said valve means upon the loss of formation at said bit.

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4. A drill bit auxiliary according to claim 3 wherein said formation sensing means comprises a plurality of drop rods located in said bit.

5. A drill bit auxiliary according to claim 4 wherein said means actuated by said sensing means comprises a supporting ring for said slideable doors and enlarged stop shoulders on said drop rods for supportably contacting said ring.

6. A drill bit auxiliary according to claim 5 further including a second ring mounted above said supporting ring and having rods connected thereto for actuating said second valve means, and means for moving said second ring with said first ring when said doors are closed.

7. A drill bit auxiliary according to claim 6 further including means for connecting some of said drop rods to said first valve means for actuating same.

8. A drill bit auxiliary according to claim 7 further including latching means for holding at least some of said drop rods in a retracted position so long as the walls of the formation at said bit location are solid.

9. A drill bit auxiliary according to claim 8 further including retractable paste catching members for supporting said paste as it is extruded from said tubes.

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